N94-21325

LET YOUR FINGERS DO THE WALKING .... THE PROJECTS MOST INVALUABLE TOOL

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1. INTRODUCTION

The barrage of information pertaining to software being developed on a project can be overwhelming. Current status information as well as the statistics and history of software releases should be "at the fingertips" of project management and key technical personnel. This paper discusses the development, configuration, capabilities, and operation of a relational database, the System Engineering Database (SEDB) which was designed to assist management in monitoring of the tasks performed by the Network Control Center (NCC) Project. This database has proved to be an invaluable project tool and is utilized daily to support all project personnel.

1.0 DEVELOPMENT METHODOLOGY

The development of the SEDB utilizes a spiral methodology, whereby capabilities are prototyped, implemented and testing concurrently. Each capability provided by the SEDB is "prototyped a little, implemented a little, tested a little, prototyped a little more, implemented a little more, and tested a little more". Throughout development the primary users of each capability are significantly involved by utilizing the prototype and providing comments. This reiterative methodology prevents the full implementation of a capability that is not useful or appropriate for the users. The use of such a methodology has been shown to be significantly efficient and effective for all types of software development.

The initial SEDB development was to provide a tracking mechanism for impact assessments. Its original purpose was merely to provide a database in which

these impact assessments would be logged. As this capability was being prototyped, Quality Assurance (QA) was in need of a better problem reporting database. The impact assessment capability was therefore modified and prototyped again to include the problem report capability. This initial development determined the methodology for all future database efforts. Project personnel determine a need and work closely with the database developers in ensuring its correct implementation.

2.0 CONFIGURATION

The SEDB is capable of supporting a project in a standalone mode or in a LAN configuration. A standalone configuration only allows one user at a time access to the database. The requirements for a standalone configuration are as follows:

- 486DX33 PC
- 8 MB RAM
- 200 MD HD
- Laser Printer
- DOS 5
- RBase Version 4.0

To allow multiple users simultaneous access to the database, a LAN configuration is required. The NCCDS Project utilizes the following LAN configuration:

Workstation:	486DX33
	8 MB RAM
	200 MD HD
	EtherNet Card
Fileserver:	486DX 33
	8 MB RAM
	500 MB HD
	EtherNet Card
Laser Printer	

The software requirements are as follows:

DOS 5
Novel Netware

RBase Version 4.0

The LAN components (10 base - twisted pair) are as follows:

HUB
Patch Panel
Telco Block
Level 4 Wiring

The SEDB can be run with a copy of RBase Runtime (this is available at no cost from the author), thereby eliminating the need to purchase RBase 4.0. RBase Runtime, however, does not allow software modifications on the PEDB.

3.0 SYSTEM ENGINEERING DATABASE SEGMENTS

The SEDB is comprised of four major segments: the Project Engineering Database (PEDB), the Configuration Management Database (CMDB), the Requirements Database (RQDB), and the Hardware Resources Database (HWDB). This section specifically describes each of these segments and the benefits each segment provides to the project.

3.1 Project Engineering Database (PEDB)

The PEDB segment is the most heavily utilized segment of the database. It manages all project problem reporting data such as System Trouble Reports (STRs), System Problem Reports (SPRs), and Integration System Problem Reports (ISPRs). In addition, the PEDB also is used to manage all other potential project impacts, such as NCC Requirements Inputs (NRIs), Minispecifications, and future impacts. The PEDB also provides the user with the capability to submit/review SEDB database problem reports. The PEDB allows project management to retrieve this data for:

- History information (e.g., How long did it take Development personnel to turnaround fixes to problems found during System Testing for a particular release two years ago? What was the Development turnaround time for a release six months ago?)
- Current status of a particular problem/impact entity/release (how many ISPRs have been closed currently in Integration Testing?)
- Planning purposes (e.g., how many DSI does a future release contain if we include the resolution to these STRs?)

The PEDB offers four significant benefits to a project. One major benefit is that it allows searching of problem reports and impact entities by any data field. This allows the database user to find what he/she needs using any information available. For example, a problem report can be searched by number, a text string, system functionality, responsible organization, problem type, priority, status, and/or system configuration.

Secondly, the PEDB automates the preparation of reports which can be displayed and/or printed. These reports can be created by the database user utilizing the search capability to generate the information desired or by utilizing the standard reports currently existing on the PEDB. One example of a standard report that is of significant importance to a project is the weekly release status report (see Figure 1) which is automatically generated using the PEDB. This report provides detailed information about the status of all problems for a particular release.

A third major benefit of the PEDB is that it provides current, consistent statistical data. Since all the project data is kept on one database, all project personnel have access to the same data and the assurance that the data is the most current.

Finally, the PEDB provides a historical archive for analysis. All data for previous releases can be accessed through the PEDB. This historical data can be utilized to provide release history information and defect causal analysis data (e.g., the number of problems written against each subsystem, the average length of time required to resolve each problem, the number of problem reports by problem type, etc.).

3.2 Configuration Management Database (CMDB)

The prime responsibility of the CMDB segment is to track software through the development process, that is, to manage CM information. The CMDB segment was created to replace manual CM logs. CM personnel enter data into the CMDB directly from internal software delivery forms received from Development personnel. This allows the CMDB to generate and identify delivery contents for a specific build and/or release for a specific time period (see Figures 2 and 3). In addition, the CMDB allows the monitoring of CM level status for all units,

Release Leader:Z. Johnson BUILD 0 SPR STATUS REPOR For RELEASE:3 AS OF:09-16-93 PAGE:23.

Type	Log Number	Pri	Assigned To	Description	Status	SU Chg	DOC Chg	DAT Chg	SYS Chg	CM Chg	BUILD Req	Code	Dev Facility
SPR	930621-0242	3	A. MORGAN SPS DEV	ACK RECEIVED FLAGS THAT ARE SET TO "YES", FOR SGT AND WSC, BY ATS TRANSMISSION ARE RESET TO "NO" AFTER AN SPS COLDSTART. NOTE:WHEN ACK RECEIVED FLAGS ARE SET TO "YES" BY TRANSMISSIONS TO EACH GT SEPARATELY THE FLAG REMAINS SET TO "YES" AFTER COLDSTART.	CLOSED 08-24-93	NO	NO	NO	NO	NO	NO		

STATUS	DATE
DATE WRITTEN	06-18-93
DATE RECEIVED	06-21-93
ASGN TO SPS DEV	06-21-93
QA	06-25-93
TO RL LEVEL 1	06-25-93
TO CM LEVEL 1	06-29-93
TO IT	06-29-93
IT CLOSED	07-07-93
TO RL LEVEL 2	07-07-93
TO CM LEVEL 2	07-07-93
TO ST LEVEL 2	07-08-93
ST CLOSED	08-24-93

Type	Log Number	Pri	Assigned To	Description	Status	SU Chg	DOC Chg	DAT Chg	SYS Chg	CM Chg	BUILD Req	Code	Dev Facility
SPR	930623-0243	4	DESANTIS/MORGAN CCS/SPS DEV	CHAPTERS 1-5 OF THE C.O.U.G. DO NOT REFLECT THE CHANGES MADE IN R380. FOR EXAMPLE, PAGES 3-4 AND 3-5 HAVE NOT BEEN REPLINED (ADF REFERENCES NOT DELETED), NOR HAS PAGE 5-67 (GETABLE DISPLAY LIST NOT CHANGED).	CLOSED 09-10-93	NO	YES	NO	NO	NO	YES		

STATUS	DATE
DATE WRITTEN	06-23-93
DATE RECEIVED	06-23-93
ASGN TO DEVEL	06-23-93
QA	07-23-93
TO RL LEVEL 1	07-23-93
TO CM LEVEL 1	07-23-93
TO IT	07-27-93
IT CLOSED	08-11-93
TO RL LEVEL 2	08-11-93
TO CM LEVEL 2	08-11-93
TO ST LEVEL 2	08-11-93
ST CLOSED	09-10-93

Type	Log Number	Pri	Assigned To	Description	Status	SU Chg	DOC Chg	DAT Chg	SYS Chg	CM Chg	BUILD Req	Code	Dev Facility
SPR	930625-0244	3	D. DESANTIS CCS DEV	AFTER DOWNING THREE SITES FOR WHICH UPD HAD BEEN SELECTED, NM RECEIVED AN INFORMATION ALERT,"NM-PERF DATA TRANSMIT PROBLEM CONTINNING TO 09/03 SELECTED SITES" WHERE 09 IS THE NUMBER OF THE SELECTED SITES WITH TRANSMISSION PROBLEMS. THE 09 IN THE INFORMATION ALERT SHOULD READ 03.	CLOSED 08-27-93	NO	YES	NO	NO	NO	NO		

STATUS	DATE
DATE WRITTEN	06-24-93
DATE RECEIVED	06-25-93
ASGN TO CCS DEV	06-25-93
QA	07-13-93
TO RL LEVEL 1	07-13-93
TO CM LEVEL 1	07 13-93
TO IT	07-13-93
IT CLOSED	07-15-93
TO RL LEVEL 2	07-15-93
TO CM LEVEL 2	07-15-93
TO ST LEVEL 2	07-15-93
ST CLOSED	08-27-93

Figure 1. Example of a weekly release status report generated by the Project Engineering Database (PEDB).

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Date : 05/28/93

      List of XXX units delivered for RELEASE 93.1

   Unit Name                                  Type     Action

   APPGBL.MMS                                 M          C
   BELLTA                                     s          d
   BELLTARA                                   c          a
   CALTSYN                                    S          C
   CCCFERP                                    S          C
   CCCFERP1                                   S          C
   CCCFERP2                                   S          C
   CCCINIT                                    S          C
   CCCISBU                                    S          C
   CCCISCT                                    S          C
   CCCISRP                                    S          C
   CCCISRP1                                   S          C
   CCCISRP2                                   S          C
   CCCISUB                                    S          C
   CCCISYN                                    S          C
   CCCISYN1                                   S          C
   CCCLSPS2                                   S          A
   CCCNORQ                                    S          C
   CCCPTUD                                    S          C
   CCCRAPP                                    S          C
   CCCRAPS                                    S          C
   CCCRASD                                    S          C
   CCCRASW                                    S          A
   CCCRPRE                                    S          A
   CMCCDY                                     S          C
   CMCDYN                                     S          C
   CMCICS                                     S          C
   CMCNCS                                     S          C
   CMCRAP                                     S          C
   CMCSDP                                     S          A

End of data for XXX (where XXX = Segment)

Unit Type = S(ource), T(emplate - SPS), P(roc - SPS),
         Q(LP Report - SPS), H(Schema/Subschema - SPS),
          R(unstream - SPS or ITS, (Mapstream - SPS),
          I(nclude File - CCS, NFE, ITS), D(ata File - CCS, ITS),
          C(ommand Procedure - CCS), M(MS Description File - CCS,
          or O(ther)

  Action = A(dd), C(hange), or D(elete)

                    Page :   1
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Figure 2. Example of a Configuration Management Database (CMDB) report listing units delivered for a release.

S D F S T A T U S R E P O R T

This report lists fixes installed in the SDF for RELEASE 93.1 since the start of System Test.

Report Date : 5/28/93

CCS - Current Diskpack : 93_1

ITS - Current ID : 93.1

SPS - Current Onlines : NCC*NCC.ONLINE
NCC*NCC.SPS

NFE - Current ID : 93.1

REQUIREMENT	DATE DELIVERED	SEGMENT	LEVEL	
SCR 71	2/9/93	CCS	N/A	
SPR 92-12-01-303	2/9/93	CCS	N/A	
SPR 92-12-09-312	2/3/93	CCS	2	
SPR 92-12-21-331	2/11/93	CCS	2	
SPR 93-01-22-013	4/5/93	CCS	2	
SPR 93-01-25-022	2/11/93	CCS	2	
SPR 93-02-02-040	3/28/93	CCS	2	
SPR 93-02-02-041	3/28/93	CCS	2	
SPR 93-03-16-114	4/9/93	CCS	2	
SPR 93-03-17-119	4/1/93	CCS	2	
SPR 93-04-13-164	4/13/93	CCS	2	
SPR 93-04-26-0186	4/28/93	CCS	N/A	
SPR23	5/31/93	CCS	2	*
MINISPEC IT032	1/15/93	ITS	2	
SPR 92-12-10-318	2/25/93	ITS	2	
SPR 92-12-31-336	1/15/93	ITS	2	
SPR 93-01-18-010	1/29/93	ITS	2	
SPR 93-02-19-069	4/7/93	ITS	2	
SPR 93-03-15-110	3/25/93	ITS	2	
93.0QF1 MERGER	4/23/93	SPS	2	
Runstreams	12/14/92	SPS	N/A	

* - New item within the last week

If you have any questions regarding this report, please contact <processor's name> in <processor's location> or at <phone number>.

Figure 3. Example of a Configuration Management Database (CMDB) report listing the status of problem resdutions installed in the Software Development Facility (SDF).

i.e., it verifies that the appropriate units are propagated to specific testing levels.

The CMDB provides three major benefits to the project. One significant contribution is that the CMDB provides QA with a Software Engineering Notebook (SEN) verification tool. QA can utilize the CMDB to ensure that Development SENs are accurate by comparing such information as delivery dates, frequency of unit deliveries, and type of unit changes.

A second contribution of the CMDB is that it provides CM with a much need internal organizational tool. It eliminates all costs associated with maintaining manual logs. In addition, the CMDB maintains easily accessible CM historical information for analysis purposes.

Finally, the CMDB provides an online reporting capability for CM. Specifically, CM personnel can automatically generate reports for (1) units delivered for a specific build/release, (2) deliveries processed at any point in time, and (3) elapsed time between when CM personnel received a delivery and when it was processed.

3.3 Requirements Database (RQDB)

The RQDB segment manages the text of the NCCDS Detailed Requirements Document (530-DRD-NCCDS). Specifically, the RQDB provides on-line accessibility to the requirements to all project personnel. The RQDB offers browse and search capabilities, thereby allowing project personnel to find on-line a requirement(s) text by paragraph number and/or a text search. The RQDB allows only approved personnel to update the database with approved Document Change Notices (DCNs) and Revisions. All project personnel, however, have the capability to enter comments on each requirement. These comments are saved as attachments and are normally used to provide information on software versus operational requirements, and/or impact assessments performed on a specific requirement.

The RQDB also manages the relationship of the system software and test cases to requirements. Specifically, all system Computer Software Configuration Items (CSCIs), units, modules and executables are mapped to individual requirements. The lines of code associated with each software unit are also maintained in the

RQDB. The capability to perform an online search for units is available to users. As a system security measure, users are allowed to download this software data but are prevented from uploading data. In support of system testing, the RQDB provides a mechanism to map a test case to each requirement, thereby allowing the automatic generation of test and implementation matrices (see Figure 4).

The RQDB provides four significant benefits to the project. The first benefit is the result of the requirements being automatically updated by downloading the requirements document file(s) into the database. This capability ensures complete accuracy of the requirements.

Second, the RQDB allows project personnel to perform string searches to identify associated requirements to the specific requirement being examined. This capability allows individuals to quickly find all requirement references to a specific item.

A third major benefit is the capability to automatically create implementation and test matrix reports. This feature provides reports that list each requirement, the associated CSCI, the test case and type, and the implementation date. This information is updatable for each release and allows efficient generation of reports for various requirements and design reviews.

Finally, the RQDB provides the capability to access online Delivered Source Instruction (DSI) counts. Each requirement is mapped to its associated DSI. This capability allows personnel to quickly determine the impact of implementing or changing a requirement.

3.4 Hardware Resource Monitoring Database (HWDB)

The most recently developed segment of the SEDB is the Hardware Resource Monitoring Database (HWDB). This segment was developed to provide for entry of data related to hardware resource usage time. As the NCC utilizes two development facilities [the Software Development Facility (SDF) and the Development Test and Training Facility (DT&T)], each with several types of equipment, the HWDB provides comprehensive resource utilization data for a specific time period (e.g., weekly, monthly). This data provides the time

NCCDS REQUIREMENTS IMPLEMENTATION REPORT page 1

Requirement #	Para. #	Requirement	Verif.	Allocation	Impl.Date
	5.0	SECTION 5. SERVICE PLANNING			
	5.1	INTRODUCTION			
	5.2	PREREQUEST ACTIVITIES			
	5.2.1	GENERAL			
05020104-0100	5.2.1.4	The NCCDS shall have the capability to store initial load data, configuration codes, and prototype events for 100 spacecraft in the NCC data base. --NOTE-- In the Baseline NCCDS, the effective capacity is 50 spacecraft.	T	14022000 14024000 14028000 54061000	 10/15/94 10/15/94
05020105-0100	5.2.1.5	To facilitate the management of the SN scheduling data base, the NCC DB shall be provided with the following capabilities:			
05020105-0100a	5.2.1.5	Enter a new Spacecraft Identification Code (SIC) and related spacecraft data into the data base.	T	14023000 14026300	10/15/94 10/15/94
05020105-0100b	5.2.1.5	For each SIC, the related spacecraft data includes a list of valid support identification codes (SUPIDENs).	T	14023000	10/15/94
05020105-0100c	5.2.1.5	Delete a SIC and related spacecraft data from the data base.	T	14023000 14026300	10/15/94 10/15/94
05020105-0100d	5.2.1.5	Modify spacecraft data within the data base.	T	14026400 14026500	10/15/94 10/15/94

VERIF. METHOD CODES: A - Analysis D - Demonstration I - Inspection T - Test

ALLOCATION: * In all cases, the most significant four digits of allocation are HWCI or CSCI number. Additional characters (if any) specify a software design structure. In most cases, such a software design structure is a software component (SC).

Figure 4. Example of the NCCDS implementation report generated by the Requirements Database (RQDB).

requested by the user, time allocated, and time actually used. In addition, the HWDB maintains lost time data and provides the capability to enter lost time reason codes by day and by hardware resource type. Based on the above information, the HWDB provides management a tool to review or automatically generate reports via several options including, but not limited to: organization, facility, time period, requestor, release, and lost time summary (see Figure 5).

The primary benefit provided by the HWDB is that the maintenance of hardware usage data provides a history of resource utilization. This information is useful for determining how many resource hours are being lost and the reasons for the lost time. In addition, resource utilization metrics are useful for projecting future resource needs for similar releases.

4.0 OPERATIONAL USAGE OF SEDB

The SEDB may be utilized by all project personnel. Figure 6 illustrates an overview of SEDB usage. Specifically, the following provides the normal utilization of the SEDB for each project group:

- o QA - enter/update SPR and STR data
  - compare delivery contents generated from the CMDB to Development SENs (validation tool)
- o CM - enter/update software baseline data
  - verify appropriate units propagated to specific testing levels
  - report CM data
- o Test - enter test case data for requirements
  - generate test status information
- o Development - review SPR and STR status
  - review impact assessment information
- o Maintenance - review SPR and STR status
  - review impact assessment information

RELEASE: <ALL>
ORGANIZATION: <ALL>

NCC/DT&T H/W RESOURCE
FOR WEEK BEGINNING
08/16/93
SCHEDULE(S) IN HOURS

As of 09/02/93

	RAP3			CCS			ITs			IT 15			SPS			NTS			OCR			ENCC		
DAY	RT	TR	AT	RT	TR	AT	RT	TR	AT	RT	TR	AT	RT	TR	AT	RT	TR	AT	RT	TR	AT	RT	TR	AT
Mon	24	24	24	20	18	16	14	12	14	14	12	4	14	12	9	14	12	12	0	0	0	0	0	0
Tue	20	20	20	32	26	28	14	14	14	12	6	6	26	20	22	26	20	22	0	0	0	0	0	0
Wed	48	48	48	38	32	32	14	14	14	12	6	6	26	20	20	26	20	20	0	0	0	0	0	0
Thu	30	24	24	26	14	14	14	14	14	12	0	0	26	14	14	26	14	14	0	0	0	0	0	0
Fri	30	24	24	26	14	14	14	14	14	12	0	0	26	14	14	26	14	14	0	0	0	0	0	0
Sat	24	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sun	24	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wk	200	188	188	142	104	104	70	68	70	62	24	16	118	80	79	118	80	82	0	0	0	0	0	0
Mth	392	380	380	270	214	214	198	178	180	152	96	88	246	190	189	264	208	210	65	65	65	0	0	0

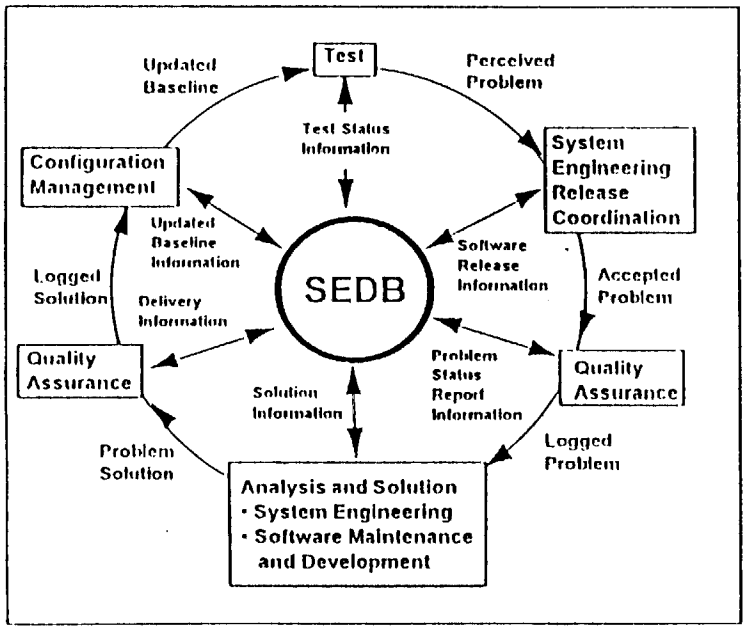
REQUESTOR	ORGANIZATION	RELEASE
BUTCH	Acceptance Test	N/A
LISA	Acceptance Test	93.1.1
FEIL	Development	N/A
VAN METER	Maintenance	N/A
OPS	Operations	N/A
GAIL	System Test	93.1.1
GAIL	System Test	R3B0
WOLFF	System Test	N/A

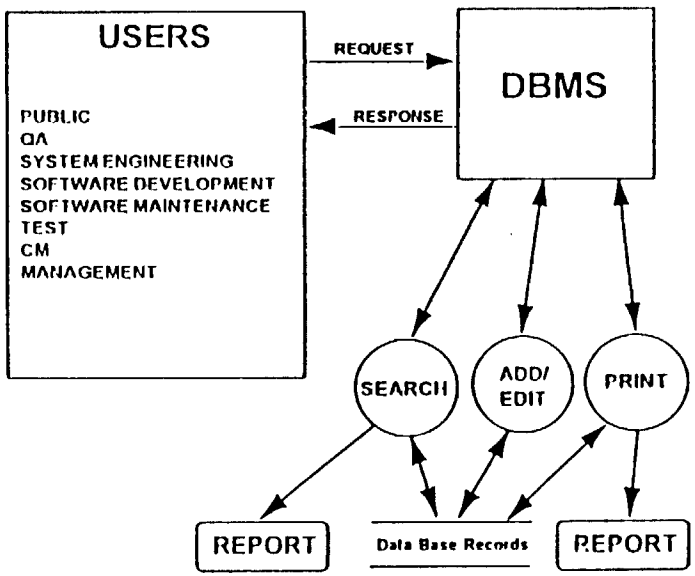
RT = Requested Time
TR = Time Received
AT = Actual Time Utilized

Figure 5. Example of a Hardware Resource Monitoring Database (HWDB) report for a one week period.

Systems Engineering Data Base

TECHNOLOGY/ DESIGN	Flexible - conforms to user reports Efficient - available via LAN; no delays for paperwork Accurate - all information from one source, online updating Menu Driven - reduces user training time, helps eliminate operator confusion





QUALITY IMPROVEMENT/AUTOMATED PROCESSES	
Search	- by log number, keyword/phrases, or other significant fields; "Ad Hoc" queries allowed
Add/Edit	- access restricted by user group, form and field
Report	- any combination of fields; data may be sorted on these fields; user definable

Figure 6. Overview of Systems Engineering Database (SEDB) usage.

- o System Engineering - enter/update impact assessment information
  - enter/update defect causal analysis data
  - generate DSI counts for requirement impact assessments
  - create software release status reports
  - enter/update resource utilization information
- o Management - review software release status
  - review SPR/STR status
  - review resource utilization metrics

Access to the SEDB for any add/edit capability is restricted by user group, report form, and data field. This ensures that all information contained within the database is protected from unauthorized access.

The SEDB allows all users to search data by log number, keyword/phrases or other significant field. This provides a mechanism for quick access to specific information.

In addition, the SEDB allows reports to be generated based on any combination of fields, that is, data may be sorted on these fields. Users can define what information is desired for a specific report.

The operational usage of the SEDB provides significant advantages to the project. It is flexible - it allows reports to be quickly created for specific users. The SEDB is efficient - it is immediately accessible via the LAN, therefore there is no need for paperwork delay. Since all information is from one source with an online updating capability, the SEDB is also accurate. All project personnel have access to the same information. Finally, since the SEDB is menu driven, user training time is minimal and operator confusion is virtually eliminated.

5.0 FUTURE ACTIVITIES

It is anticipated that the SEDB will be utilized on other projects; for example, it has been successfully transported and utilized on the X-Band Synthetic Apperture Radar (XSAR) project. Although the future plans for the SEDB depend upon funding, the following represent some of the potential capabilities that are being examined for possible implementation:

- Display Graphics and Graphical Outputs
- Personnel Resource Management Database
- Online Interface Control Documents (ICDs) and Data Format Control Documents)
- Cost Estimation

6.0 SUMMARY

In summary, the SEDB is an excellent tool that provides access to standardized and consistent data. It facilitates management by allowing the monitoring all tasks within their purview and provides a method to produce task required products in a timely, accurate and consistent formats. It can be utilized by the entire project and provides a basis for continuous process improvement.